THE GOODNESS OF SALT QUICK TEST AS COMPARED TO TITRATION METHOD FOR MASS SCREENING OF THE IODINE LEVEL IN THE COMMUNITY

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ABSTRACT

Diagnostic study on Quick salt test and titration methods toward Urine Intake Excretion (UIE) level in Indonesia had been conducted after the baseline data of Iodine salt available (Riskesdas 2007). For the baseline, samples were selected purposively covering households of 30 districts/municipalities based on the previous Iodine Salt Survey (SGY 2993). The dependent variable was Iodine level of UIE, and the independent variables were salt quick test and titration. Analysis were by: 1) linier regression to determine correlation between the salt titration and UIE; 2) Analysis of variance was to compare mean difference between of UIE and quick salt test as well as titration; and 3) Chi-square test was to determine risk factors of two examined variables. Results showed that there was correlation between titration and UIE level by the power of 7.3% and can be explained by 0.5%. Significance Chi-Square test showed, there was significance difference of UIE level according to quick salt test (p=0.000; OR 1.762). Similarly to titration, there was significance difference of UIE level according to titration p=0.001; OR=1.740). ANOVA test showed that there was significance difference of UIE according to titration (p=0.019), although the means difference was not so wide (means of enough iodine was 274.73 mcg and less of iodine was 248.38 mcg) respectively. In conclusion, the implementation of both salt quick test and titration result was significance toward the UIE level. The quick salt test was more sensitive compare to titration, but, the later was more specific. Nevertheless, the salt quick test is more benefited as it is cheaper, handy, and simple to conduct. It was recommended that salt quick test to be used to determine the iodine level for massive screening to predict the UIE level because it has correlation, sensitivity, simple, easy to be implemented and applicable in future.

Key words: *diagnostic study, Iodine in salts, Iodine in urine*

ABSTRAK

Studi diagnostik tes garam cepat dan titrasi garam terhadap kadar yodium dalam urin sebagai upaya monitoring program penanggulangan GAKY di Indonesia merupakan analisis lanjut Riskesdas 2007 sebagai baseline data kesehatan di Indonesia. Sampel dipilih secara purposive yakni rumah tangga dari 30 kabupaten/kota yang tercakup dalam survey sebelumnya (SGY 2003). Hasil analisis menunjukkan ada hubungan antara titrasi garam dengan urin intake excretion (UIE) dengan kuat hubungan 7,3% dan hubungan tersebut dapat dijelaskan sebesar 0,5%. Uji Chi-square menunjukkan ada perbedaan yang signifikan kadar UIE menurut tes garam cepat (p=0,000), dengan peningkatan faktor resiko terhadap kandungan yodium dalam urin (OR=1,762). Demikian juga untuk kadar UIE menurut titrasi garam yang juga menunjukkan perbedaan yang signifikan (p=0,001; OR=1,740). Tes Anova menunjukkan ada perbedaan yang signifikan kadar UIE menurut titrasi garam (p=0,019). Mean UIE dengan titrasi cukup yodium = 274,73 mcg dan kurang yodium=248,38 mcg; sebaliknya tes garam cepat menunjukkan tidak ada perbedaan. Penggunaan tes garam cepat maupun titrasi garam memberikan hasil signifikan terhadap UIE. Tes garam cepat memiliki nilai yang lebih sensitif daripada titrasi garam, tetapi titrasi garam memiliki angka yang lebih spesifik. Namun demikian, penggunaan tes garam cepat secara ekonomis jauh lebih murah dan mudah dibandingkan titrasi garam. Sebagai rekomendasi, tes garam cepat berhubungan dengan UIE sehingga dapat digunakan untuk prediksi kadar UIE yang lebih murah dan mudah dilakukan. Penggunaan tes garam cepat untuk penilaian kadungan yodium garam di masyarakat cukup signifikan, sensitif serta efisien dibandingkan dengan uji titrasi, sehingga dapat direkomendasikan sebagai metode yang cukup aplikabel dimasa yang akan datang.

Kata kunci: *studi diagnostik, kadar yodium garam, kadar yodium urin*

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INTRODUCTION

The Presiden decree number 69/1994 stated that all salt distributed over Indonesia country has to proper Iodine contain. This policy concern to the high prevalence of Iodine Deficiency Disorder or IDD (1). Among 20 million population with IDD, the lost of Intelligent Quotient (IQ) point has estimated about 140 million due to the IDD (2). IQ point is a measurement of man's ability in terms of thinking, problem solving as well as adaptation capability to a new situation.

Salt quick test has been used nationally in the Health Baseline Research (HBR) year 2007 that held by the National Institute of Health Research and Development, Ministry of Health of Indonesia (3). The method assessed the Iodine content of salt in the household by two drops of Kalium Iodate (KIO3) solution. In addition, the research used titration method to the household's salt sample as well as urine of school children aged 6–12 years. Thirty districts had been selected purposively from three categorization areas namely endemic non-endemic and in between areas of IDD.

Analysis were based on data taken from the Baseline Health Research (Riskesdas) from 30 districts representing the country that previously were also samples of Iodine Salt Survey (SGY) year 2003. Purposes of the analysis were to compare the methodology and to determine the best method in efforts of program management and monitoring. Mass-screening and mass-treatment were assessed by sensitivity and specificity test for intervention and or problem solving purposes.

There are two methods to assess Iodine content in salt namely salt quick test and titration, although both are different. The first test is considered simple and easy to be done as well as cost effective. Meanwhile the second is commonly used, but it needs more sophisticated infrastructure such as laboratory as well as expertise; so it is more expensive. Comparing the two tests, it is assumed that salt quick test can be more preferable, but how is the accuracy if it could replaced by the titration method?

The objective of thr research was to determine the best method for Iodine salt assessment aimed reducing the IDD prevalence by companing the sensitivity and specificity tests results to the gold standard.

METHODS

This study is a further analysis of secondary data of the Baseline Health Research 2007. Some variables were taken from salt samples and were further analyzed to determine sensitivity and specificity of the methods, so the best method for mass-screening was found.

Design of the study was cross-sectional. Samples of household in the BHR 2007 were framed from the National Socio-economic Survey (NSS) 2007 as core samples among 280.000 households. Same household were separated by natural borders, which is called census block. Data collected for quick salt test were from 257,065 household samples, however samples for titrated salt and urine test were from 8,473 sample households of the 30 districts representing the country. These districts were purposively selected referring to the previous survey namely Salt Survey in 2003 conducted by the Central Bureau of Statistic with category of high, mild and non endemic areas IDD and of representation high, medium and low iodine salt consumption (4).

Source secondary data of the BHR 2007 involving 1990 salt samples over 27 districts combining salt quick test, laboratory assessment of salt titration and iodine urine assessment among school children aged of 6–12 years. The variables were 1) Iodine level of salt quick test; 2) Iodine level of salt titration, and 3) Iodine level of urine 'Urine Iodine Excretion' among the children.

Instruments data collection of BHR 2007 were 1) BHR/RKD07 quistionnaire household RT (block II, number 6) was asking if a household keeps salt and (number 7) the salt used in the household and then conducting quick test. Question number 8 was taking salt samplefor laboratory titrated test; 2) Questionnaire BHR/RKD07.INDIVIDU, block assessment (question number 13) for taking urine sample only to household members children aged of 6–12 years. Results of salt quick test was provided directly from the questionnaires. However, results of the salt titration and urine test were from the laboratory test to the specimens taken accordingly by stickers.

Salt quick test was done by two drops of Povidon 'KIO3' solution over two table spoons of salt speciment. It showed the proportion of household consumed non iodine salt (identified by no color of test result), salt

with adequate iodine content or less than 30 ppm (by color of light blue/magenta), salt with enough Iodine content (by color of dark blue/magenta). For salt titration test to determine iodine level of the salt taken from the household pots or containers. Finally, laboratory results of the urine test confirmed with the salt titration results among selected household to categorize wether iodine intake of the members were enough.

Data processing and analysis were by SPSS 15.0 version, the analysis were bivariate analysis, linear regression, analysis of variance (ANOVA) and Chi-square test. The linear regression was used to determine correlation of the iodine level between the titration results and UIE. Both variables were continue type of data. Analysis of Variance (ANOVA) test was conducted to determine statistically significant relations between salt quick test and salt titration test. In addition, Chi-square test was to determine risk factors of salt quick test, salt titration toward urine intake excretion (UIE)

RESULTS

Prior to analysis, data cleaning was done toward 64 missing values among households that a) keep salt and b) results of salt quick test. In these cases, the missing values were replaced by a) households that kept salts and b) results of the quick salt test adjusted to the salt titration results so data could be analyzed refersing to the salt titration and UIE results that were completely available. Frequency distribution of variables tested were done, before conducted regression analysis.

1. Iodine Level of Salt and Urine Samples

Based on the salt titration test, the proportion of households consuming salt with enough iodine (≥30 ppm) was only 23.4%, meanwhile the laboratory examination for urine intake excretion (UIE) results showed that 67% of school children among household samples had consumed enough iodine (≥100 mcg/l). The proportion of UIE ≥300 mcg/l seemed greater in urban than rural population.

Linear regression analysis was to determine the correlation between iodine level of salt titration and iodine level of UIE. Results showed, there was a correlation between iodine level of salt titration and iodine level of urine intake excretion (p=0.001). It was positive correlation with a correlation strength of 7.3% (r=0.073) and could explain the inclination of the UIE by 0.5%. The regression model was explained in the formula as:

Y(UIE) = 233,4 + 0,95 salt titration (see graph 1)

that, for every 1 ppm of titration can increase 0.95 mcg UIE. This formula can be used to estimate the level of UIE by only conducting titration test to the salt consumed. For example, if the level of iodine from titration is 30 ppm, then it can be predicted that the iodine level of the urine of the school child would be 233.4 + 0.95 (30) mcg = 261.9 mcg.

The ANOVA test toward salt titration and UIE showed there was a difference of iodine level in urine according to salt titration. It means UIE of the titration for the iodine level of ≥30 ppm was 274.73 mcg, and was significantly difference (p=0.019) to the iodine level of the titration <30 ppm of which means that of UIE 248.38 mcg.

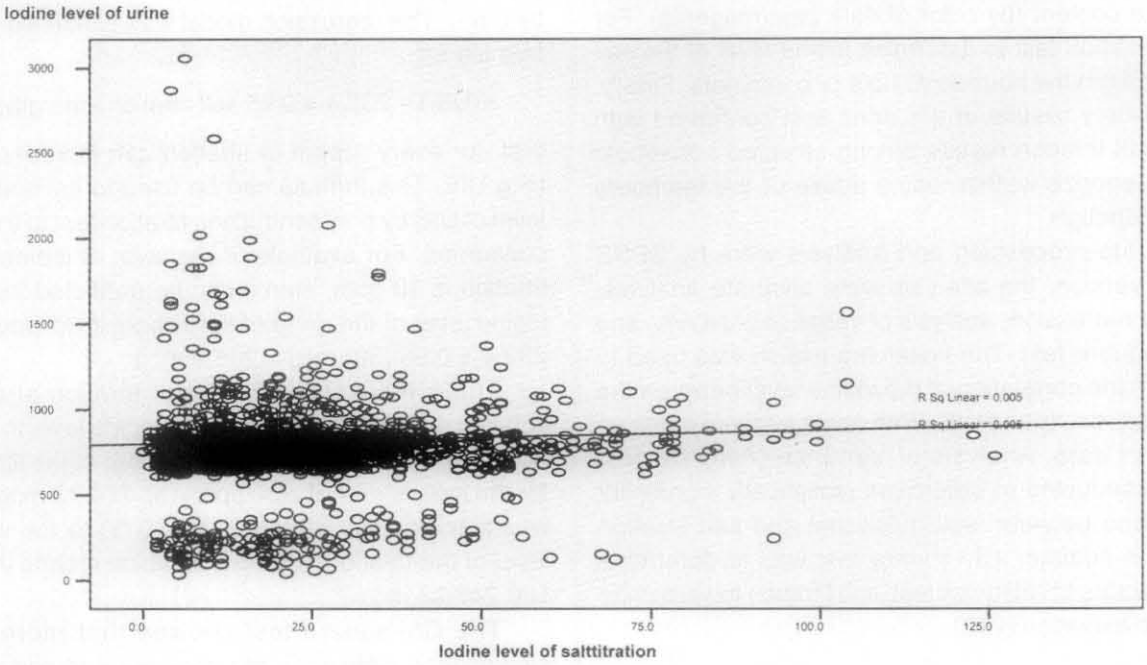
The Chi-square test showed that there was significance difference of iodine level of salt quick test and UIE (p-0.00). Salt quick test without or with limited iodine were at risk to the low iodine level in urine (OR=1.76) comparing to the salt quick test with enough iodine.

There were differences between Iodine level from salt titration result and Iodine level in urine. Salt titration test for the category of less iodine was at risk to lower the iodine level in the urine (p-0.00; OR=1.74).

Table 1. Correlation of salt quick test and titration towards UIE

Salt quick test	UIE		Total
	≥100 mcg	<100 mcg	
Enough Iodine	1043	117	1160
(dark blue) %	89,9	10,1	100
No/less Iodine	693	137	830
(light/no color) %	64	36	100
P			0.00
OR			1,76
Salt titration			
Enough Iodine	426	40	466
(≥30 ppm) %	91,4	8,6	100
Less Iodine	1310	214	1524
(<30 ppm) %	86,0	14,0	100
P			0,00
OR			1,74

Graphic 1. The correlation of the iodine level of salt titration and UIE



2. Diagnostic Test

Results of diagnostic test between salt quick test and titration for UIE as the gold standard are presented in Table 2 below. The purpose of doing the diagnostic test of salt quick test and titration towards Iodine urine is to determine sensitivity and specificity of the methods used. Results of this assessment were expected to provide information on the best method for mass-screening and mass-treatment in future in terms of validity, accuracy, simplicity and other benefited factors.

The assessment was done by utilizing results of the laboratory analysis of the urine's iodine level that expected to be fulfilling the 'recommended dietary intake'. The value of UIE draws the iodine level of the body metabolism that is taken as the gold standard. Results of the salt quick test and titration assessment then compared to the point UIE to determine the sensitivity and specificity values.

Validity of the salt titration is represented by sensitivity (se) and specificity (sp) and significance Kappa (p). Sensitivity is the proportion of the true positive of the result and specificity is the proportion of the true negative. These tests are implemented to both salt quick test as well as salt titration of the household salt samples.

From the table can be seen that there is difference significantly (p=0.00) towards Kappa results, the sensitivity of the salt quick test is 60.2% which means it gives a better results to detect the iodine level in salts than salt titration, though the specificity is nearly neutral (53.9%).

Salt titration result based on WHO standard (cut-off ≥30 ppm) shows significant (p=0.00); which

Table 2. Kappa confirmation of the Salt quick test and titration

No	Variable	Sensitivity (%)	Specificity (%)	Significancy Kappa (p)	Reliabi-lity Kappa
1	Salt quick test	60,2	53,9	0,000	0,071
2	Salt titration (cutt-off ≥30)	24,54	84,25	0,002	0,028

means there is difference of salt titration result towards iodine urine. It can be seen that the sensitivity is so weak (24.5%0, though the specificity is very good (84.3%).

Reliability is the level of accuracy happened when the test procedure is conducted repeatedly. The purpose of conducting reliability test is to look over the variation among assessment done by one enumerator and or many enumerators. Reliability is simultaneously be used to assess the variation between the enumerators in doing the salt quick test in the field or household. The Kappa value shows that when the reliability of the assessment results is between -1 and +1 with the significance $p<0.05$ the reliability is consider good.

The Kappa value of 0.028 to 0.071 (check table) shows the range of the result is proper (between -1 and +1) between a laboratory analysts or, between assessments of a laboratory analyst. It can also be interpreted as the reliability of an enumerators to some samples or between enumerators to many samples for salt quick test is good.

DISCUSSION

The proportion of iodine level from the UIE assessment where 67% of the population did consume enough iodine (>=100 ppm) is expectedly great. Iodine level in urine indicated the latest iodine consumption by individual subject. When more than 50% of the children aged 6–12 years old have iodine urine <100 mcg/L, it can be assumed that the community having problem with iodine deficient. The median value of 100–299 mcg/L reflects the iodine consumption in the population has fulfilling the recommended allowance, meanwhile the median greater than 300 mcg is excessive. However, Miller said that over iodine consumed gave a positive impact to health (5).

The iodine urine in the urban population is higher compare to the rural area. Unfortunately, we do not analyze food intake and consumption of the community that might affect the iodine urine. Nevertheless, one possible answer this situation can be assumed that the consumption pattern in the urban areas vary and tends to have more ready to eat food or fast food which is rich in iodine fortified salt and sodium.

Regression analysis showed there is correlation of iodine level in salt titration and urine's iodine. The more iodine in food is consumed the higher the iodine content in the urine. The result of this correlation analysis shows significant and show influence of the inclination of iodine level in urine towards salt titration. In addition, ANOVA test of salt titration also shows the difference of iodine level in urine significantly. In conversely, the quick salt test shows there is no difference of iodine level in salt. This may be due to subjectivity among enumerators when he or she has to determine the color of light blue/magenta and dark blue/magenta which is irrelative. Chi-square test shows significantly difference and there is inclination of risk factor of salt quick test and titration toward iodine level in urine. The test result consistently proves to conduct assessment in the field, although both methods have different ways of assessment.

Salt quick test is considered very simple and easy to be done. This test can be conducted by anybody within household by a simple training. It is also cheap compare to salt titration. For the salt titration, it needs a sophisticated infrastructure such as laboratory, reagents as well as human resources. In other word, it needs more money, materials and methods. In addition, it takes more time, for example collecting the salt sample in the field before it sending to the laboratory. Managing samples is also a difficulty, such problems in transportation, contamination, mixing of specimens, etc.

Diagnostic test gives enough evidence that conducting salt quick test in the field is respectively efficient and the result can be proven more sensitive compare to titration. The validity and reliability are significant to salt test be implemented as compare to titration method, though the later has better in specificity.

CONCLUSION

1. There was correlation between salt titration and iodine urine a correlation of (r=7.3%) and significant of 0.5%.
2. Chi-square test showed there was significance difference of iodine urine by salt quick test (p=0.000), with increasing risk factor to iodine level in the urine (OR=1,762). Similarly to the iodine urine by salt titration which was significantly difference (p=0,001; OR=1,740).
3. ANOVA test showed a significance difference of iodine urine by salt titration (p=0,019). Means of UIE for titration of enough iodine was 274,73 mcg,

less iodine was 248,38 mcg; in conversely, there was no difference of iodine urine according to salt quick test.

4. Implementation of salt quick test as well as titration were resulting a significance results to UIE. Moreover, salt quick test is more sensitive than titration, but the later has more specific value. Nonetheless, salt quick test more benefited as it is simpler, cheaper, and easier to be conducted.

RECOMMENDATION

1. Socialization of salt quick test is necessary not only to the policy makers, but also to the community in order to control the salt's quality in the community. Acceleration of iodine salt consumption would help Indonesia to faster the achievements of Universal Salt Iodization in the country.
2. Salt quick test is associated to UIE so that it can be used to predict the urine's iodine which is cheaper and easier to be done.
3. The usage of quick salt test for mass-screening is more significant, sensitive and efficient comparing to titration and can be adopted and recommended in the future.
4. Further research is needed to determine factors affecting iodine urine level in urban population, so the prevention of excessive affect could be anticipated.

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